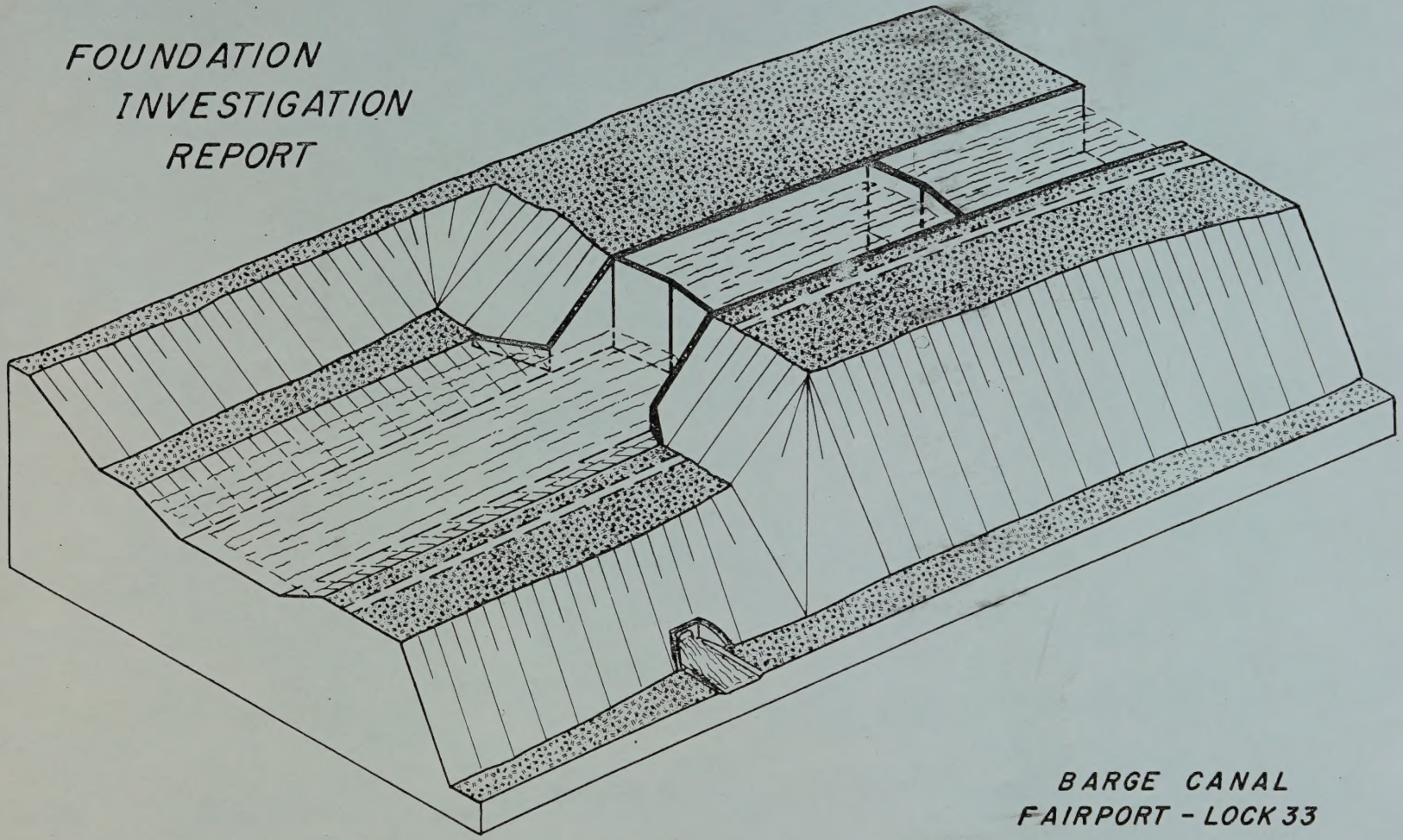
FOUNDATION INVESTIGATION REPORT



BARGE CANAL
FAIRPORT - LOCK 33

SOIL MECHANICS BUREAU

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

FOUNDATION INVESTIGATION REPORT

PHYSICAL CONDITION SURVEY
BARGE CANAL - WESTERN SECTION
FAIRPORT TO LOCK 33
P.I.N. 4940.29 - 101

LYNDON H. MOORE DIRECTOR
SOIL MECHANICS BUREAU

ALBANY NEW YORK

AUG. 1975

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
Raymond T. Schuler, Commissioner

1220 Washington Avenue, State Campus, Albany, New York 12226

June 20, 1975

Mr. George M. Briggs, Director
Transportation Maintenance Division
NYS Department of Transportation
1220 Washington Avenue
Albany, New York 12232

Subject: Transmittal of Canal
Condition Survey Report
Fairport to Lock 33
PIN 4940.29-101

Dear Mr. Briggs:

In accordance with your request dated December 16, 1974, this Bureau has completed a physical condition survey of the Barge Canal between Fairport and Lock 33.

The report presents the results of a thorough inspection and investigation of the canal in the study area. Accepted standards and practices used by Soils engineers for design of earth dams and water retaining structures were used to evaluate the safety of the canal and furnish recommendations for correcting existing deficiencies.

This Bureau's participation in this project has been under the direction of R. H. Burns, P.E., Associate Soils Engineer assisted by R. S. Cheney, P.E., E. A. Fernau, P.E. and R. L. Gemme, P.E. all Senior Soils Engineers. Formal acknowledgment is noted herein of the excellent cooperation received from the following personnel from Region 4: C. K. Burkwit, Regional Waterways Maintenance Engineer, T. J. Mahaney, Technical Services Engineer, R. J. Wilson, Soils Engineer, Marcus Levinson and R. M. VanPatten, Surveying.

This report which details pertinent foundation aspects of the subject canal area should be used in conjunction with reports from other involved Bureaus and Subdivisions in evaluating the overall canal condition. If any questions arise concerning this report, please contact us. We are continuing progression of a similar foundation study for the remaining sections of the Barge Canal between the Wayne County border and Lockport. This report is anticipated to be completed by January 1, 1976.

Very truly yours,

LYNDON H. MOORE, Director
Soil Mechanics Bureau

By

Richard H. Burns
Associate Soils Engineer

RHB:MR

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Albany, New York 12232

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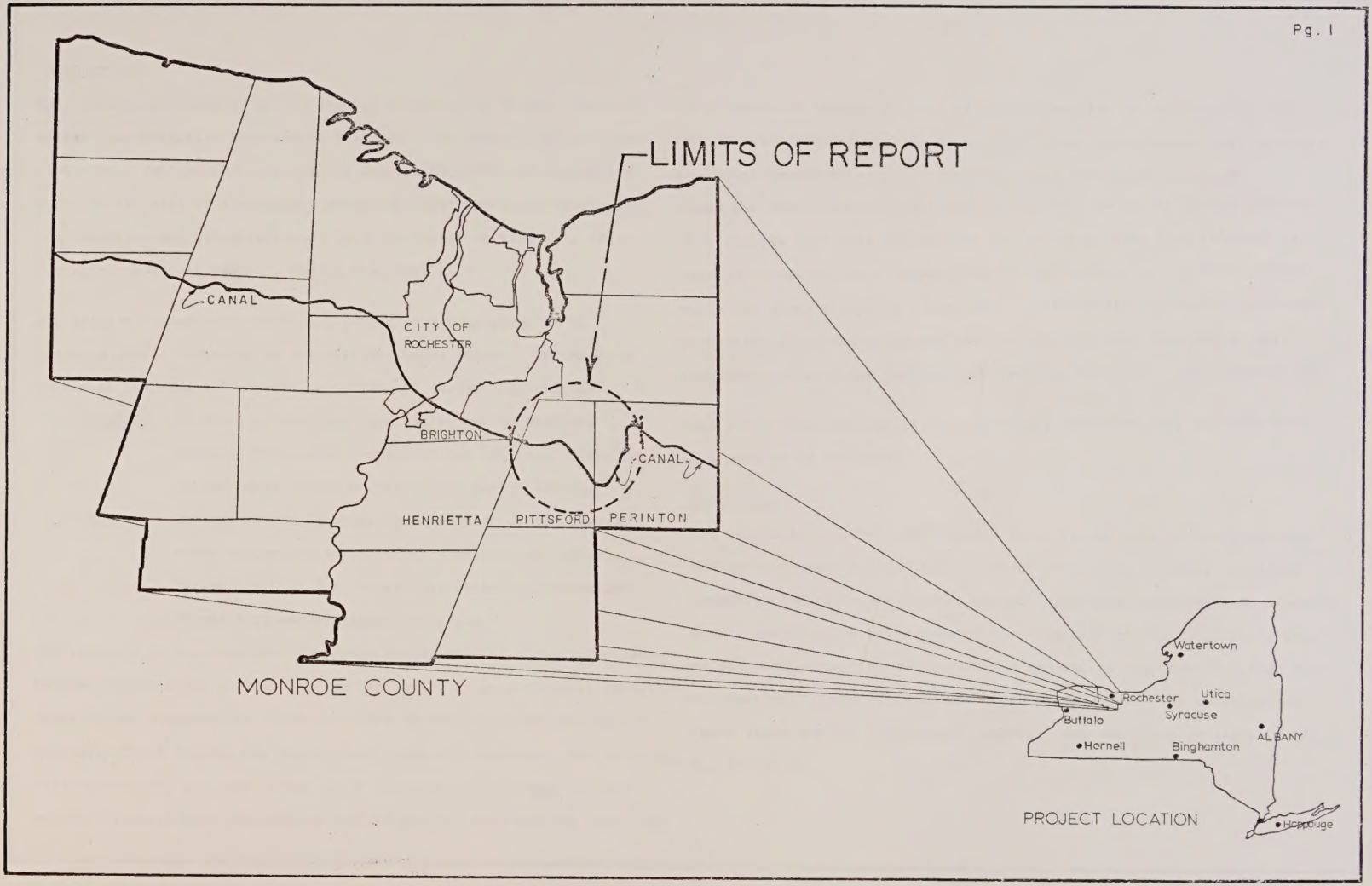

LIMITS OF REPORT
CANAL
CITY OF ROCHESTER
BRIGHTON
CANAL
HENRIETTA
PITTSFORD
PERINTON
MONROE COUNTY
Watertown
Rochester
Utica
Syracuse
Buffalo
ALBANY
Hornell
Binghamton
PROJECT LOCATION

INTRODUCTION

This report was prepared at the request of George M. Briggs, Director of the Transportation Maintenance Division. The request was a direct result of a failure that occurred on October 29, 1974, at Bushnell's Basin in the area of a tunneling operation under the canal embankment. The tunneling was being performed by a contractor working on a project for the Irondequoit Bay Pure Waters District.

Mr. Brigg's request was translated into a work plan prepared by Lyndon H. Moore, Director of the Soil Mechanics Bureau. Mr. Moore's work plan included a "Purpose" and a "Scope", defined as follows:

"PURPOSE - To develop long range monitoring and maintenance programs to provide continuous and efficient operation of the canal system and to insure public safety."

"SCOPE - To inspect and document the condition of the present canal system; to evaluate the condition and prepare recommendations for future corrective and preventive maintenance and monitoring programs."

The sequence of work included immediate preparation of a condition report between Fairport and Lock 33 and implementation of an additional condition report to be completed by January 1, 1976 on the remaining sections of the Barge Canal between the Wayne County Line and Lockport. The section between Fairport and Lock 33 was to be completed immediately for two reasons, several high embankments existed in this area and the canal was in a dewatered condition which allowed inspection of the concrete structures. The future study between the Wayne County Line and Lockport will encompass the remaining major areas of existing canal embankment sections.

Under the scope outlined the staff of the Soil Mechanics Bureau embarked on a program that included walking the entire section from Fairport to Lock 33 to make on site inspections and evaluations of the canal embankments and water retaining structures. Additionally, historical documents pertaining to planning, design and construction were examined as were incidences of previous failures and remedial measures. (See Appendix B)

This report presents the results of a very comprehensive, in-depth study of a portion of the canal.

CONCLUSION

The inspection of the canal between Fairport and Lock 33 in the Spring and early Summer of 1975 indicated that there were no areas requiring immediate positive treatment to correct embankment deficiencies. Certain areas, amounting to approximately three percent of the total study area do not meet present day criteria with respect to top width and side slope inclination. These criteria are shown on page six. The locations of these areas and the recommended remedial work are shown on pages 9, 10, 11, 13 and 17.

PHYSIOGRAPHY, SOILS AND DRAINAGE

The study area is located in the Erie-Ontario Lowland physiographic province of the State. The topographic expression is controlled by the non-consolidated surficial deposits rather than the underlying bedrock formations. The non-consolidated deposits are the result of depositional processes associated with the glaciers of the Pleistocene epoch. Post-glacial erosional processes have shaped the landscape to its present configuration.

Prior to glaciation it is thought that the ancestral Genesee River flowed northward through a great valley now occupied in part by Irondequoit Creek. The existence of this valley has been confirmed by numerous borings and wells.

Briefly, the glacial geologic history of the study area is one of deposition of glacial till by advancing and retreating glacial ice, along with the construction of moraine and ice-contact deposits where glacial ice stagnated. Because drainage was mainly to the north the ice acted as a barrier and pro-glacial lakes were formed. Into these ephemeral lakes quantities of fine-grained sediments were deposited. As outlets were found these lakes drained to successively lower levels. One such outlet is the Fairport-Lyons outlet channel which the Barge Canal follows east of Fairport. The last of these lakes, Lake Iroquois, was at an elevation of 435-440 feet in this area. The vast filling of the ancestral Genesee valley occurred mostly during the lifetime of this lake. For an excellent and concise history of glacial lake sequences refer to the "Planning Inventory, Town of Perinton" prepared by the Monroe County Planning Council.

The soils have formed on the unconsolidated deposits of Pleistocene and Recent ages. Basically the study area may be divided into two smaller groupings. From Fairport to Cartersville the soils have formed on dominantly lacustrine deposits of silt, clay and fine sand. The exception to this being between Bushnell's Basin and Cartersville where stagnant ice produced a granular ice-contact type deposit now cut by Irondequoit Creek south of the Canal. Isolated patches of ice-contact material occur north of Cartersville. The fine-grained lacustrine soils are susceptible to erosion by flowing water as evidenced by the many ravines and gullies on either side of the Irondequoit Creek floodplain.

From Cartersville to Lock No. 33 the landscape is dominated by glacial till, a mixture of all soil particle sizes displaying no sorting, which is covered by shallow lacustrine deposits in lower areas. This material is erosion resistant. See Appendix A, Generalized Terrain Map and the explanations of the legend for more detailed information.

Drainage is entirely to Irondequoit Creek and its major tributary, Allen Creek, and thence to Lake Ontario. Surface drainage dominates the western portion of the area but the more porous lacustrine sands and silts act as reservoirs for large quantities of ground water. The canal which flows in an easterly direction, was originally designed to exclude most of the surface water of the area. Surface drainage is directed to the canal at the "Ox-Bow" widewaters west of Fairport and from the stream which drains an area south of Lock No. 32 and flows into the Lock bypass. Effluent from several waste-water treatment plants is emptied into the canal.

BARGE CANAL FIELD INSPECTION

During April and May representatives of this Bureau performed a field inspection of the Barge Canal between Fairport and Lock 33. As an aid to this inspection the following data was used:

1. A set of 1" = 200' scale photogrammetric plans prepared by Erdman-Anthony, Consulting Engineers in December, 1968.
2. A set of 1" = 200' scale plans detailing as-built canal location and other pertinent data.
3. The agricultural soil map for Monroe County.
4. Existing boring information from Department of Transportation projects -
   a. Main St.-Fairport PIN 4355.00 (see pg. 8)
   b. FARC 73-69 PIN 4750.42 (see pg. 8)
   c. FARC 54-39 (see pg. 13)
   d. Bridge E137 PIN 4037.09 (see pg. 16)
   e. FARC 60-136 - Clover St. (see pg. 18)
   f. PIN 4347. (see pgs. 10, 13, 14, 15)
   g. PIN ML 7401 (see pg. 10)
   h. PIN 4940.28 (see pg. 13)
   i. PIN 4066.11 (see pgs. 13, 17)
5. Guidelines for the Construction of Small Earth Dams published by the NYS Dept. of Environmental Conservation.
6. "Design of Small Dams," 1961, United States Department of the Interior - Bureau of Reclamation.

The inspection procedure consisted of traversing the entire area to identify and classify the condition of various sections. The primary objectives of this inspection were to evaluate present embankment stability, locate seepage areas and to identify structure foundation problems. Rough cross-sections were obtained using a hand level and survey rod in areas of suspected seepage and areas of high or steep embankment slopes.

A thorough inspection was made of the embankment side slopes to detect seepage zones. In addition, dye was injected into the canal in areas where the potential existed for embankment or structure seepage. These potential seepage areas were observed for about 15 minutes after injection to determine if the dye would appear on the outboard slope. It was assumed that the present seepage would not be a detriment to embankment stability if the time for appearance of the dye exceeded 15 minutes. In no case did the dye emerge within 15 minutes.

Structures extending through or under the canal were inspected only for foundation instability, piping or clogging. Observations and opinions of the structural condition of these structures will be presented by the Materials Bureau in a separate report.

ANALYSIS OF CANAL FIELD INSPECTION

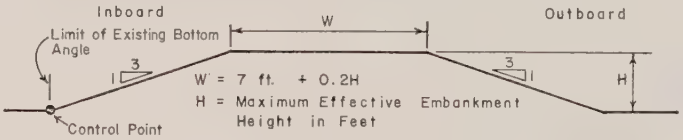
Our analysis of the canal alignment was based on embankment stability criteria, earth dike design, seepage considerations, and standard structure design practices. These analyses were used to estimate a "condition classification" and to determine recommended foundation treatment. The standard design sections used in this report for canal embankments are in accord with data contained in "Guidelines for the Construction of Small Earth Dams" published by New York State Department of Environmental Conservation. This represents the current best engineering practice and the professional judgment of staff engineers of the State Department of Transportation and the State Department of Environmental Conservation with assistance by the staff of the Soil Conservation Service, United States Department of Agriculture. The above publication is based upon earth dam design criteria established in "Design of Small Earth Dams," 1961, United States Department of the Interior - Bureau of Reclamation.

The following is a brief explanation of the geometry of the standard design canal embankment sections developed for this project.

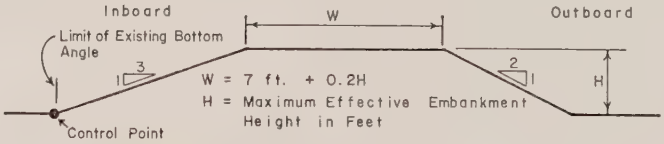
1. Inboard canal embankment slopes steeper than 1 vertical on 2 horizontal can be expected to slough or be susceptible to isolated failures due to sudden drawdown of canal water or excessive saturation due to run-off from storm water. It is not expected that these conditions would deteriorate the inboard slope beyond 1 vertical on 3 horizontal since annual maintenance is done on the inboard slopes. Therefore for determining required embankment widening it was assumed that all inboard slopes would eventually have a 1 vertical on 3 horizontal inclination.
2. The purpose of the top width requirement (W) is to provide sufficient embankment width to prevent the theoretical line of seepage from emerging on the outboard slope. Many areas on this project have an embankment top width (W) far in excess of the recommended. Areas which have side slopes much steeper than the recommended may be quite stable overall, if the top width is great. We do not recommend flattening slopes, except for maintenance cost reduction, of any section that has adequate top width based on application of the standard canal embankment section criteria; that is, any section on which the standard section is completely contained within the existing embankment section.
3. The inclination of the outboard slope is specified at 1 vertical on 3 horizontal to provide embankment stability. If seepage control measures are utilized a steeper allowable slope i.e., 1 vertical on 2 horizontal, is justified because seepage forces are reduced and embankment stability increased.

The existing canal embankment sections were compared with the standard

design sections for canal embankments shown below. This comparison is effected by establishing the inboard toe of slope (or limit of bottom angle) as a control point and then overlaying the existing cross-section with the appropriate standard section. The "sub-standard embankment sections" referred to on pages 9, 10, 11, 13 and 17 are existing embankments whose geometry does not conform to the criteria shown below:



Standard Design Section for Canal
Embankments Without Seepage Control Measures



Standard Design Section for Canal
Embankments With Seepage Control Measures

A separate analysis was performed to account for the affect of earthquakes on embankment stability. The details of this analysis are contained in Appendix C. The results of this analysis indicate that the standard design sections shown above will be stable for the expected earthquake intensity.

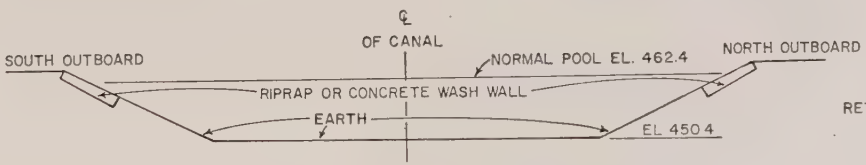
Based on the results of our field inspection of the canal embankments we have classified the condition of each area into one of four categories. These categories are as follows:

Condition Classification	Description
Class 1	Immediate Positive Treatment Required
Class 2	Future Improvement Required
Class 3	Minimal Maintenance or monitoring required
Class 4	No treatment required

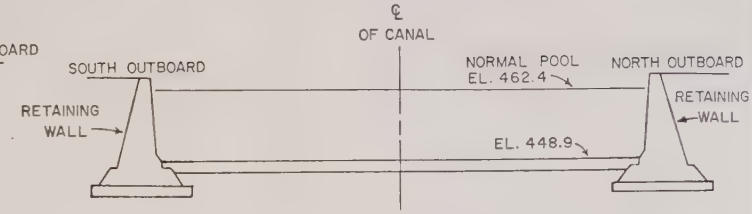
The station by station analyses which are shown on pages 8 to 19 outline the general physical description and foundation problems within each canal area. Recommended foundation treatment is shown to correct the foundation problems noted thereon.

The entire subject canal area was classified with the following results:

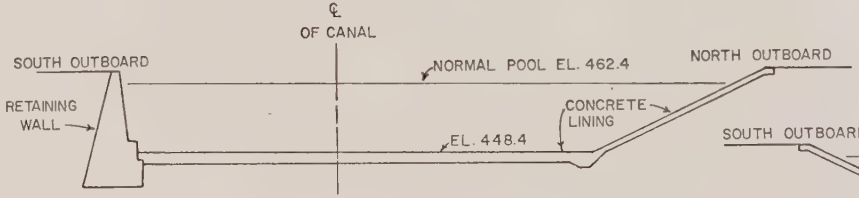
Condition Classification	Percent of Total Area
Class 1	0
Class 2	3
Class 3	5
Class 4	92



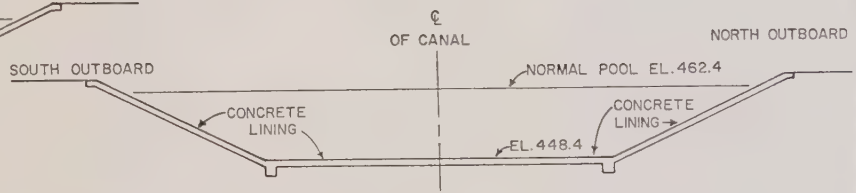
TYPICAL CANAL SECTION A



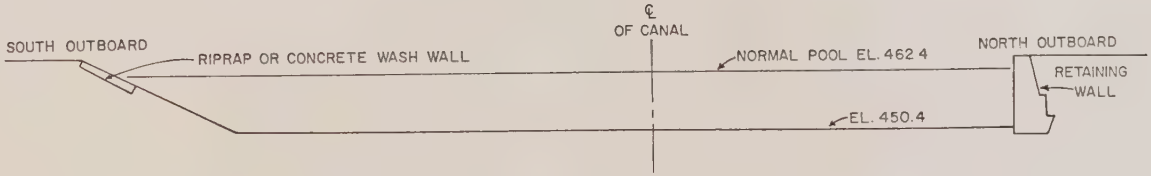
TYPICAL CANAL SECTION B



TYPICAL CANAL SECTION C



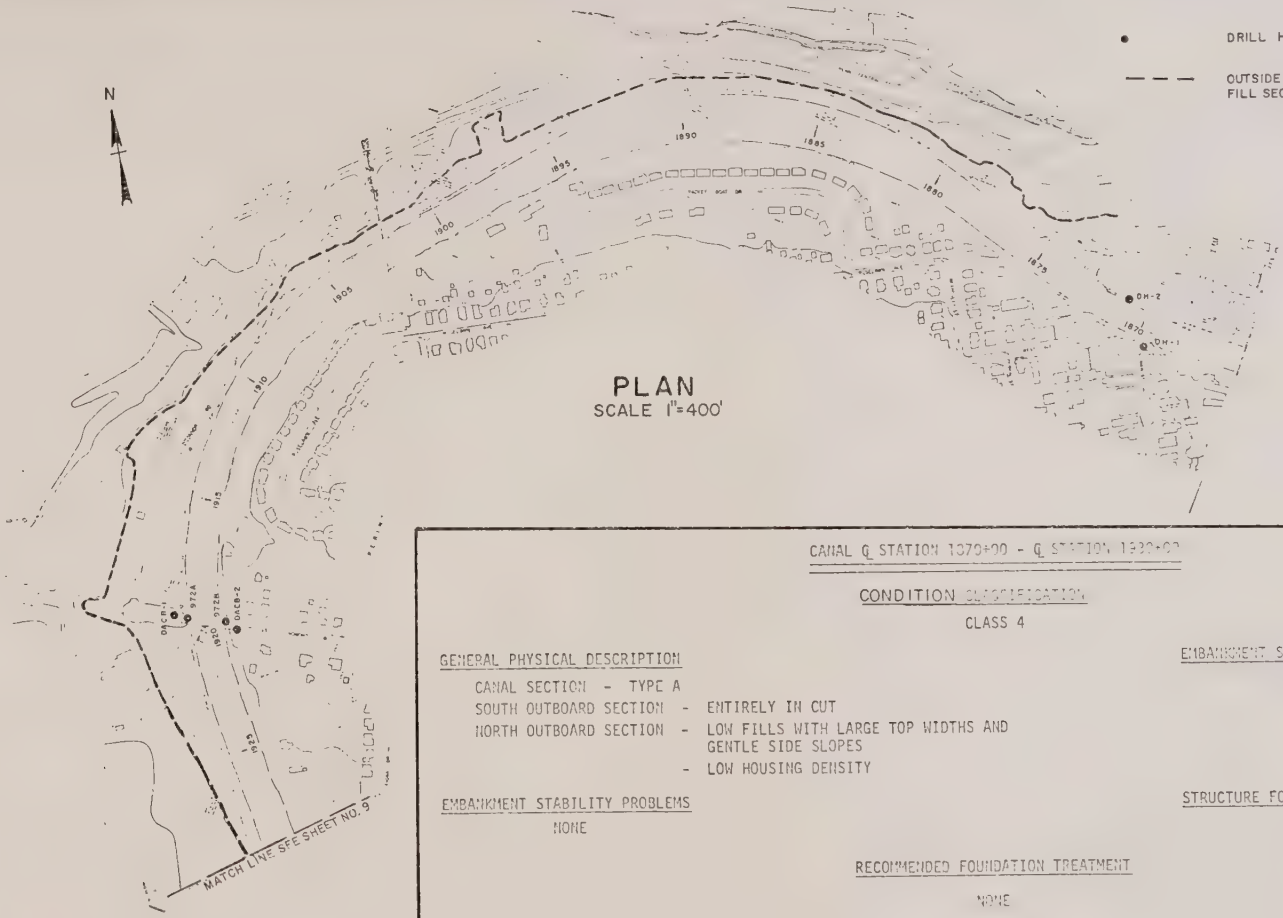
TYPICAL CANAL SECTION D



TYPICAL CANAL SECTION E

*-TAKEN FROM CANAL "AS BUILT DRAWINGS"

*TYPICAL CANAL SECTIONS



PLAN
SCALE 1"=400'

CANAL Ⓒ STATION 1370+00 - Ⓒ STATION 1430+00

CONDITION CLASSIFICATION

CLASS 4

GENERAL PHYSICAL DESCRIPTION

CANAL SECTION - TYPE A
SOUTH OUTBOARD SECTION - ENTIRELY IN CUT
NORTH OUTBOARD SECTION - LOW FILLS WITH LARGE TOP WIDTHS AND GENTLE SIDE SLOPES
- LOW HOUSING DENSITY

EMBANKMENT SEEPAGE PROBLEMS

NONE

EMBANKMENT STABILITY PROBLEMS

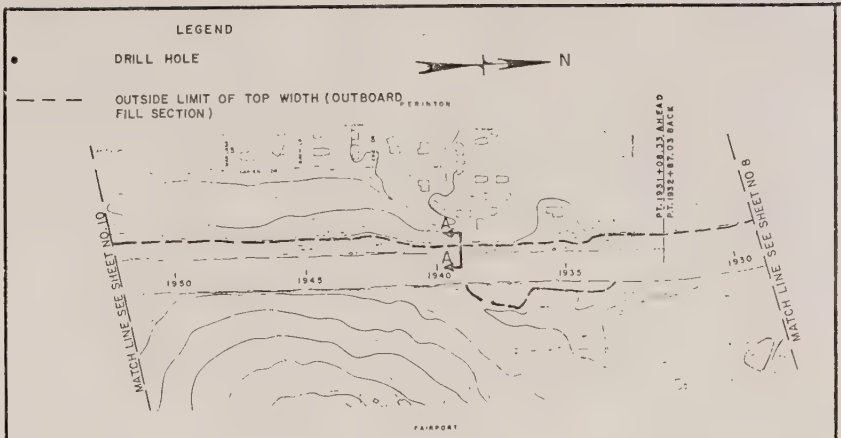
NONE

STRUCTURE FOUNDATION PROBLEMS

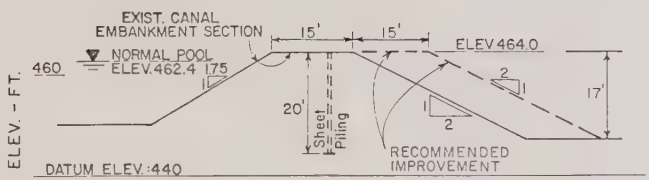
NONE

RECOMMENDED FOUNDATION TREATMENT

NONE



PLAN
SCALE: 1"=400'



SECTION A-A
SCALE: 1" = 20'

CANAL ℄ STATION 1930+00 - ℄ STATION 1952+00

CONDITION CLASSIFICATION

℄ 1938 TO ℄ 1940 - CLASS 2 (NORTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION - TYPE A

SOUTH OUTBOARD SECTION - ENTIRELY IN CUT EXCEPT LOW FILL AREA BETWEEN ℄ 1934 AND ℄ 1939
- NO HOUSING IN FILL AREA

NORTH OUTBOARD SECTION

℄ 1930 TO ℄ 1938 - LOW FILLS WITH ADEQUATE TOP WIDTH AND GENTLE SIDE SLOPES
- LOW HOUSING DENSITY

℄ 1938 TO ℄ 1940 - SEE SECTION A-A
- SHEETPILING DRIVEN THROUGH TOP WIDTH EXCEPT AT CULVERT NO. 27
- HIGH HOUSING DENSITY

℄ 1940 TO ℄ 1952 - MEDIUM FILLS WITH LARGE TOP WIDTHS AND GENTLE SIDE SLOPES
- SHEETPILING DRIVEN THROUGH TOP WIDTH
- HIGH HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

℄ 1938 - ℄ 1940 - SUBSTANDARD EMBANKMENT SECTION
REMAINDER OF AREA - NONE

EMBANKMENT SEEPAGE PROBLEMS

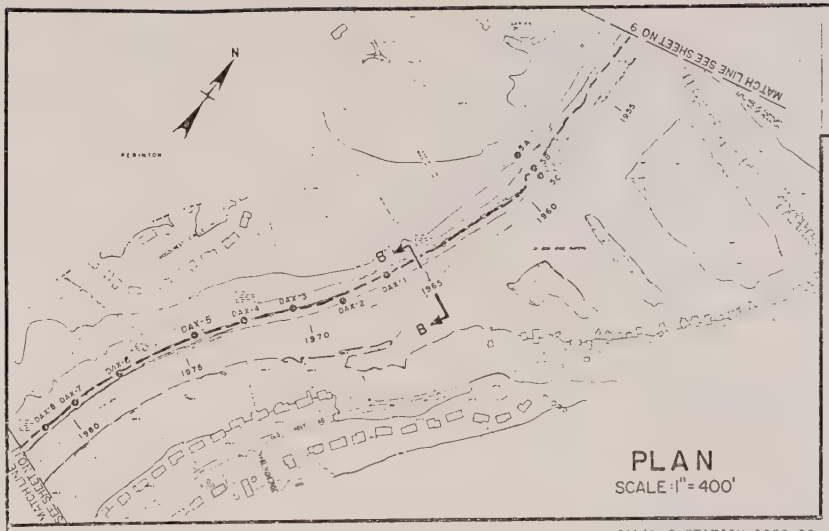
NONE - DYE TEST PERFORMED AT ℄ STATION 1939

STRUCTURE FOUNDATION PROBLEMS

℄ 1939 - CULVERT NO. 37 OUTLET CLOGGED WITH SILT AND DEBRIS
REMAINDER OF AREA - NONE

RECOMMENDED FOUNDATION TREATMENT

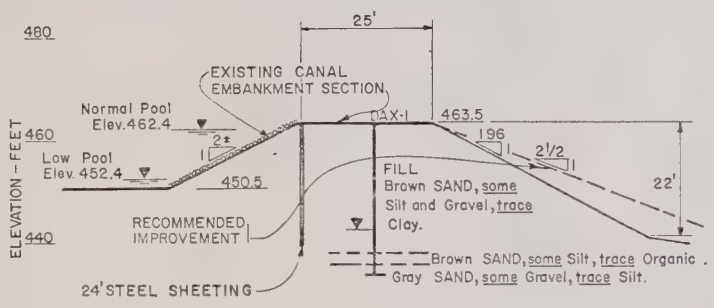
- WIDEN EMBANKMENT TO LIMITS SHOWN ON SECTION A-A
- CLEAN OUT AND EXTEND CULVERT NO. 37 TO LIMIT OF WIDENED SECTION AND IMPROVE HYDRAULICS AT OUTFALL TO PREVENT FURTHER SILTING



PLAN
SCALE: 1" = 400'

LEGEND

- DRILL HOLE
- — — OUTSIDE LIMIT OF TOP WIDTH (OUTBOARD FILL SECTION)



DATUM ELEVATION : 420

SECTION B-B
SCALE: 1" = 20'

CANAL ℄ STATION 1952+00 - ℄ STATION 1982+00

CONDITION CLASSIFICATION

℄ 1960 - ℄ 1969 - CLASS 2 (NORTH SIDE)
℄ 1974 - ℄ 1982 - CLASS 3 (NORTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION - TYPE A
SOUTH OUTBOARD SECTION - ENTIRELY IN CUT
NORTH OUTBOARD SECTION

℄ 1952 - ℄ 1960 - MODERATE FILLS WITH LARGE TOP WIDTHS AND STEEP SIDE SLOPES
- SHEETPILING DRIVEN THROUGH TOP WIDTH
- MODERATE HOUSING DENSITY

℄ 1960 - ℄ 1969 - SEE SECTION B-B
- SHEETPILING DRIVEN THROUGH TOP WIDTH EXCEPT AT TRANSMISSION LINE
- MODERATE HOUSING DENSITY

℄ 1969 - ℄ 1982 - MODERATE FILLS WITH NARROW TOP WIDTHS AND GENTLE SIDE SLOPES
- SHEETPILING DRIVEN THROUGH TOP WIDTH TO ℄ STATION 1975
- MODERATE HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

℄ 1960 - ℄ 1969 - SUBSTANDARD EMBANKMENT SECTION.
REMAINDER OF AREA - NONE

EMBANKMENT SEEPAGE PROBLEMS

℄ 1960 - ℄ 1982 - INTERMITTENT WET AREAS NOTED BELOW TOP WIDTH
- DYE TESTS PERFORMED AT ℄ STATIONS 1960, 1966 AND 1970

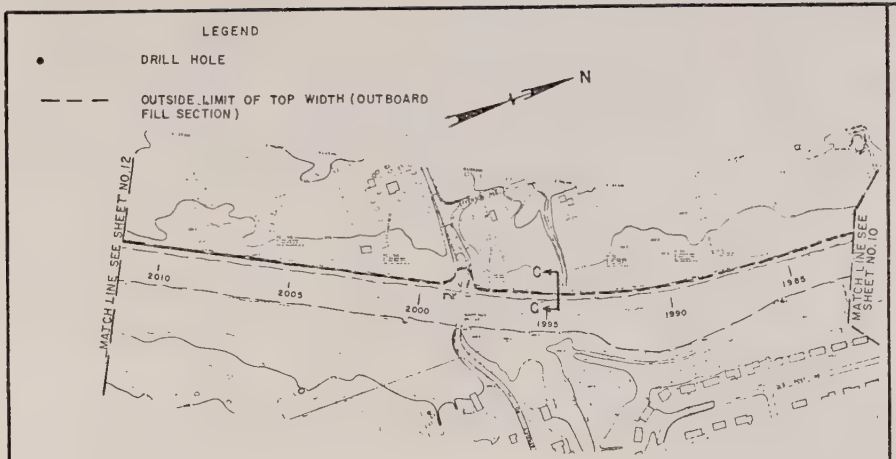
REMAINDER OF AREA - NONE

STRUCTURE FOUNDATION PROBLEMS

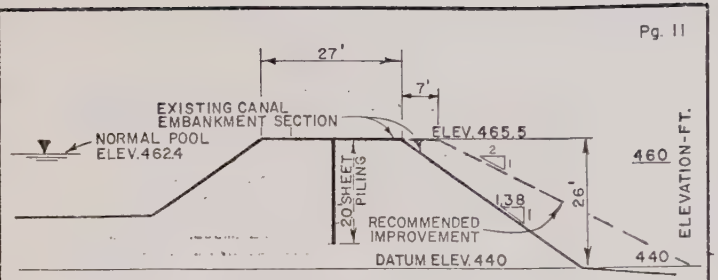
NONE APPARENT - FURTHER INVESTIGATION OF TOWER FOUNDATION REQUIRED

RECOMMENDED FOUNDATION TREATMENT

- WIDEN EMBANKMENT TO THE MINIMUM LIMIT SHOWN ON SECTION B-B TO 1 ON 2.5 SLOPE BETWEEN ℄ 1960 AND ℄ 1969
- IN AREA WHERE CANAL LEAKAGE OCCURS, LEAKAGE CAN BE VIRTUALLY ELIMINATED BY EXTENDING EXISTING SHEETING AN ADDITIONAL 5± FEET IN DEPTH FROM ℄ 1960 TO ℄ 1969 AND DRIVING NEW SHEETING FROM ℄ 1975 TO ℄ 1982



PLAN
SCALE: 1"=400'



SECTION C-C
SCALE: 1"=20'

CANAL ℄ STATION 1982+00 - ℄ STATION 2012+00

CONDITION CLASSIFICATION

℄ 1994+30 - CLASS 2 (CULVERT #28, NORTH SIDE)
℄ 2007 - ℄ 2012 - CLASS 3 (NORTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION - TYPE A
SOUTH OUTBOARD SECTION - CUT GENERALLY THROUGHOUT
NORTH OUTBOARD SECTION
℄ 1994+30 - SEE SECTION C-C
- MODERATE HOUSING DENSITY
REMAINDER OF AREA - LOW EMBANKMENT HEIGHT WITH NARROW TOP WIDTHS AND GENTLE SIDE SLOPES
- SHEETPILING THROUGHOUT EXCEPT AT BRIDGE E130 AND CULVERT NO. 28
- MODERATE HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

℄ 1994+30 - SUBSTANDARD EMBANKMENT SECTION
REMAINDER OF AREA - NONE

EMBANKMENT SEEPAGE PROBLEMS

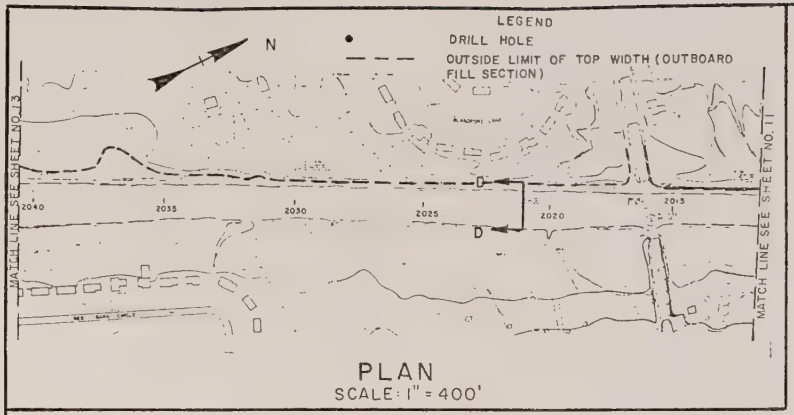
℄ 2007 - ℄ 2012 - INTERMITTENT SEEPAGE AREAS NOTED BEYOND TOE OF SLOPE
- DYE TEST PERFORMED AT ℄ 2012

STRUCTURE FOUNDATION PROBLEMS

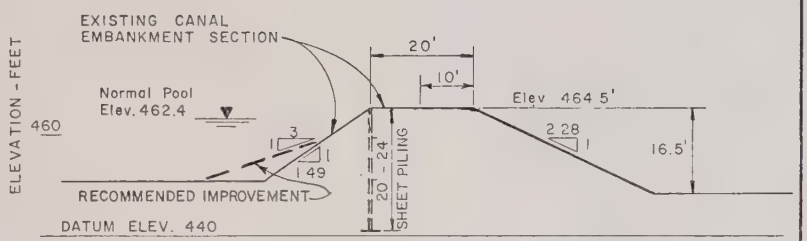
NONE

RECOMMENDED FOUNDATION TREATMENT

- WIDEN EMBANKMENT TO LIMITS SHOWN ON SECTION C-C
- EXTEND CULVERT NO. 28 TO LIMIT OF WIDENED SECTION
- BORING AND PERIODIC FIELD MONITORING REQUIRED FOR SEEPAGE OBSERVED BETWEEN ℄ 2007 AND ℄ 2012



PLAN
SCALE: 1" = 400'



SECTION D-D
SCALE: 1" = 20'

CANAL ℄ STATION 2012+00 - ℄ STATION 2040+00

CONDITION CLASSIFICATION

℄ 2012 - ℄ 2018 - CLASS 3 (NORTH SIDE)
℄ 2018 - ℄ 2023 - CLASS 2 (NORTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION - TYPE A
SOUTH OUTBOARD SECTION - CUT THROUGHOUT
NORTH OUTBOARD SECTION

℄ 2012 - ℄ 2018 - LOW EMBANKMENT HEIGHT WITH NARROW TOP WIDTH AND GENTLE SIDE SLOPES
- SHEETPILING EXISTS EAST OF BRIDGE E131 ONLY
- MODERATE HOUSING DENSITY

℄ 2018 - ℄ 2023 - SEE SECTION D-D
- HEAVY HOUSING DENSITY
- SLOPES HAVE BEEN LANDSCAPED BY ADJACENT PROPERTY OWNERS

REMAINDER OF AREA - LOW EMBANKMENT HEIGHT WITH NARROW TO MODERATE TOP WIDTHS AND MODERATE SIDE SLOPES
- SHEETPILING EXISTS INTERMITTENTLY FOR ONE THIRD OF THE LENGTH OF THIS AREA

EMBANKMENT STABILITY PROBLEMS

℄ 2018 - ℄ 2023 - SUBSTANDARD EMBANKMENT SECTION.

REMAINDER OF AREA - NONE

EMBANKMENT SEEPAGE PROBLEMS

℄ 2012 - ℄ 2018 - INTERMITTENT SEEPAGE AREAS NOTED BEYOND TOE OF SLOPE
- DYE TEST PERFORMED AT ℄ 2014

℄ 2018 - ℄ 2023 - SEEPAGE AREA NOTED AT ℄ 2019+50 AT TOE OF SLOPE
- DYE TESTS PERFORMED AT ℄ 2018 AND ℄ 2021

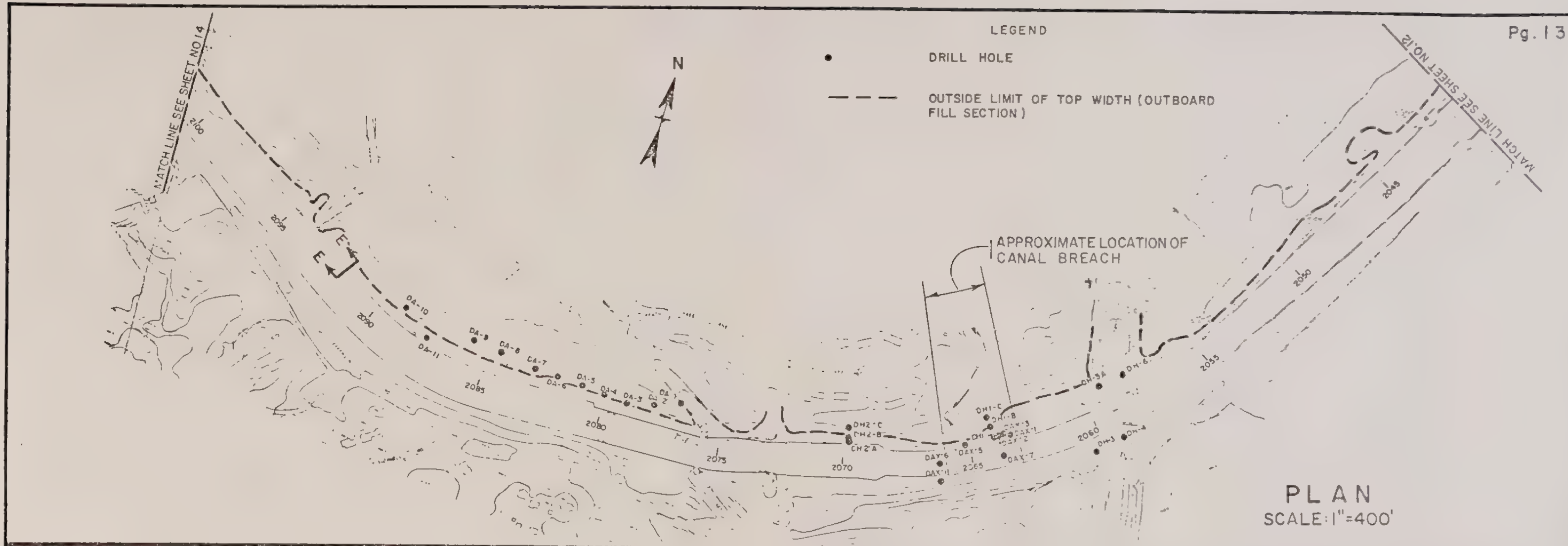
REMAINDER OF AREA - NONE

STRUCTURE FOUNDATION PROBLEMS

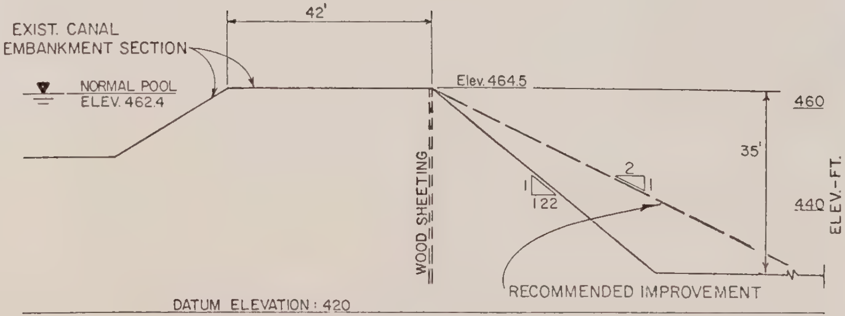
NONE

RECOMMENDED FOUNDATION TREATMENT

- WIDEN EMBANKMENT ON INBOARD SIDE TO LIMITS SHOWN ON SECTION D-D
- DRIVE NEW SHEETPILING FROM ℄ 2018 BACK TO BRIDGE NO. E131
- INCREASE DEPTH OF EXISTING SHEETPILING AS DETERMINED FROM BORINGS PROPOSED ALONG THE TOE PATH BETWEEN ℄ 2018 AND ℄ 2023
- FILL OVER SEEPAGE OUTLET AREA AT ℄ 2019+50 WITH A MINIMUM 3 FOOT THICK BLANKET OF UNDERDRAIN FILTER TYPE A (CONCRETE SAND)



PLAN
SCALE: 1"=400'



SECTION E-E
SCALE: 1"= 20'

CANAL ℄ STATI[illegible] (EXCLUDING [illegible] BASIN FAILURE AREA)

CONDITION CLASSIFICATION

℄ 2091+00 - ℄ 2092+50 - CLASS 2 (NORTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION
- ℄ 2040 - ℄ 2059 - TYPE A
- ℄ 2059 - ℄ 2075 - TYPE B
- ℄ 2075 - ℄ 2080 - TYPE C
- ℄ 2080 - ℄ 2100 - TYPE D

SOUTH OUT[illegible] SECTION - ENTIRELY IN CUT
NORTH OUTBOARD SECTION
- ℄ 2091+00 - ℄ 2092+50 - SEE SECTION E-E
  - LOW HOUSING DENSITY

REMAINDER OF AREA - LOW TO [illegible] FILLS WITH [illegible] TOP WIDTHS AND [illegible]
- SHEETPILI[illegible] TOP WIDTH OVER 20 PERCENT OF AREA
- MODERATE HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

℄ 2091+00 - ℄ 2092+50 - SUB-STANDARD EMBANKMENT SECTION

REMAINDER OF AREA - NONE

EMBANKMENT SEEPAGE PROBLEMS

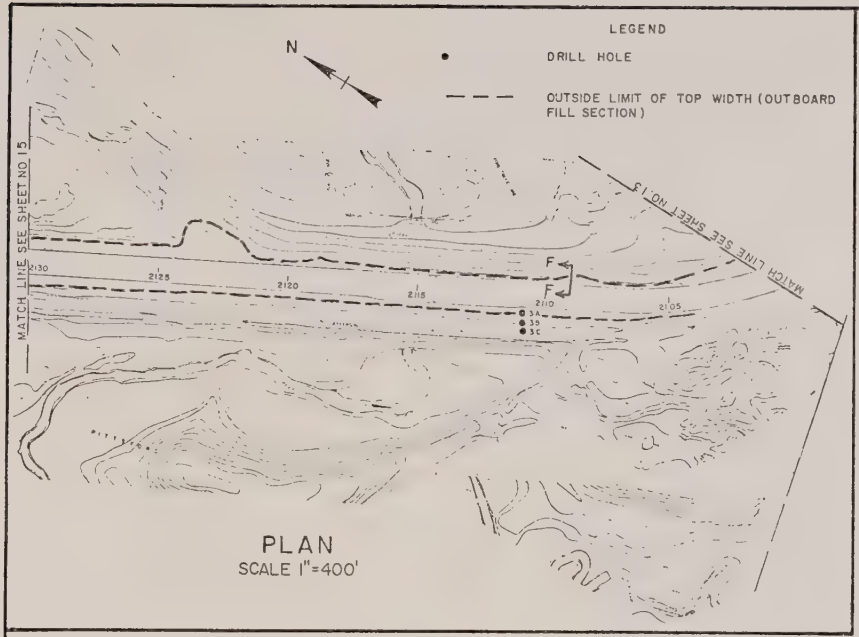
NONE - DYE TESTS PERFORMED AT ℄ 2091 AND ℄ 2094

STRUCTURE FOUNDATION PROBLEMS

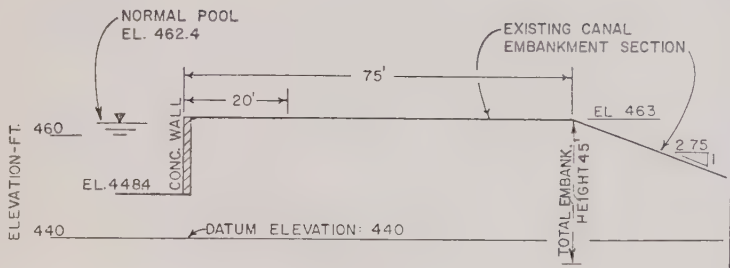
NONE

RECOMMENDED FOUNDATION TREATMENT

-FLATTEN OUTBOARD SLOPE TO LI[illegible] ℄ 2091+00 & ℄ 2092+50



PLAN
SCALE 1"=400'



SECTION F-F
SCALE 1"=20'

CANAL ℄ STATION 2100+00 - ℄ STATION 2130+00

CONDITION CLASSIFICATION

℄ 2018 - ℄ 2121 - CLASS 3 (NORTH SIDE)
℄ 2110 - ℄ 2130 - CLASS 3 (SOUTH SIDE)
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION - TYPE B
SOUTH OUTBOARD SECTION
℄ 2100 - ℄ 2105 - IN CUT
℄ 2105 - ℄ 2130 - HIGH FILLS WITH MODERATE TOP WIDTHS AND MODERATE TO STEEP SLOPES
- LOW HOUSING DENSITY
NORTH OUTBOARD SECTION
℄ 2100 - ℄ 2130 - SEE SECTION F-F
- HIGH HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

NONE

EMBANKMENT SEEPAGE PROBLEMS

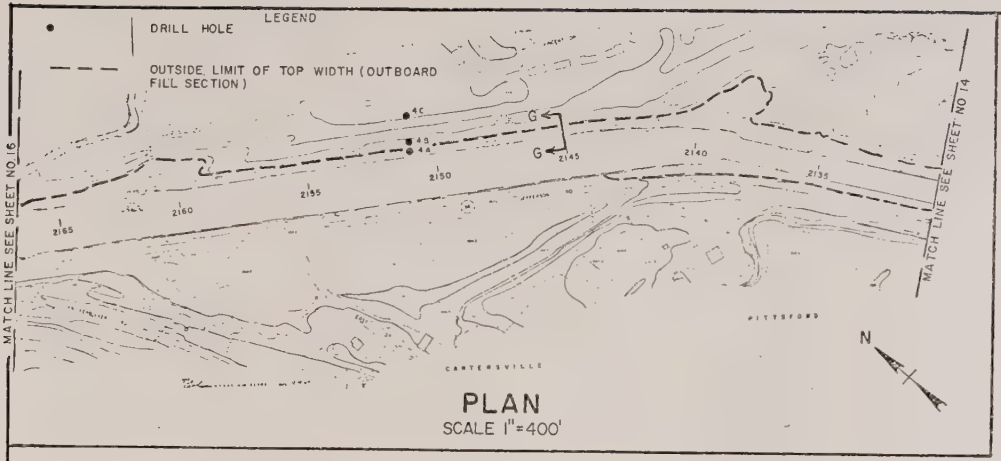
NONE - DYE TESTS RUN AT ℄ 2109, ℄ 2115, ℄ 2120 & ℄ 2125

STRUCTURE FOUNDATION PROBLEMS

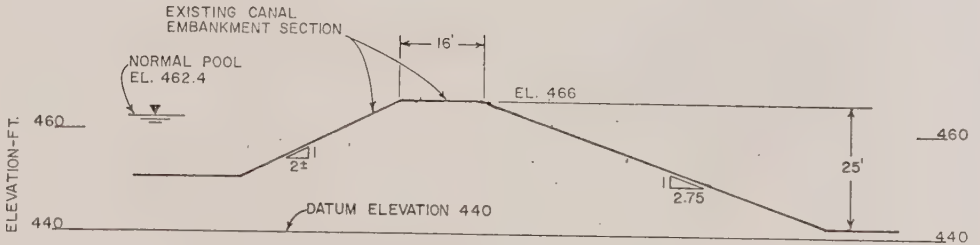
NONE

RECOMMENDED FOUNDATION TREATMENT

NONE - PENDING RESULTS OF CORING CONCRETE CANAL BOTTOM BETWEEN ℄ 2105 AND ℄ 2130



PLAN
SCALE 1"=400'



SECTION G-G
SCALE 1"=20'

CANAL ℄ STATION 2130+00 - ℄ STATION 2166+00

CONDITION CLASSIFICATION

℄ 2145 - ℄ 2155 - CLASS 3 (NORTH SIDE)
REMAINDER OF AREA - NONE

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION
℄ 2130 - ℄ 2139 - TYPE B
℄ 2139 - ℄ 2160 - TYPE D
SOUTH OUTBOARD SECTION
℄ 2130 - ℄ 2142 - HIGH FILLS WITH MODERATE TOP WIDTHS AND MODERATE TO STEEP SLOPES
- SHEETPILING DRIVEN IN TOP WIDTH BETWEEN ℄ 2140 & ℄ 2142
- LOW HOUSING DENSITY
℄ 2142 - ℄ 2166 - IN CUT
NORTH OUTBOARD SECTION
℄ 2145 - ℄ 2155 - SEE SECTION G-G
- HIGH HOUSING DENSITY
REMAINDER OF AREA - MODERATE TO HIGH FILLS WITH LARGE TOP WIDTHS AND MODERATE TO STEEP SLOPES
- LOW HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

NONE APPARENT

EMBANKMENT SEEPAGE PROBLEMS

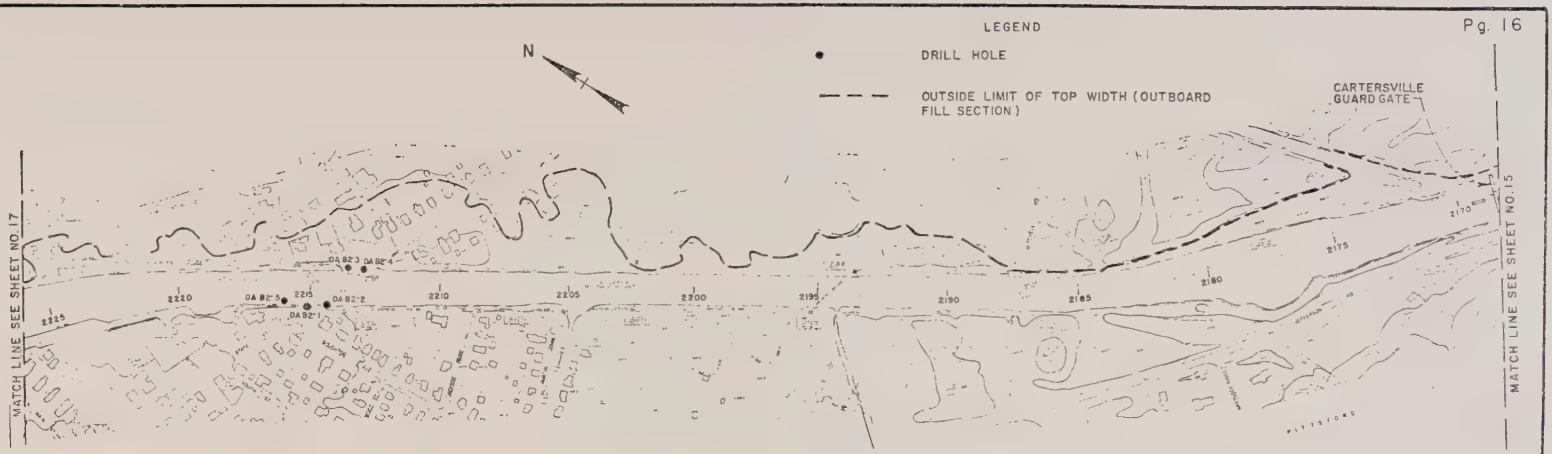
NONE - DYE TESTS SEE NOTES AT ℄ 2135

STRUCTURE FOUNDATION PROBLEMS

NONE

RECOMMENDED FOUNDATION TREATMENT

NONE ANTICIPATED - RECOMMEND CROSS-SECTIONS BE TAKEN AT 100 FOOT INTERVALS FROM ℄ STATION 2145 TO ℄ 2155 TO VERIFY EMBANKMENT GEOMETRY



PLAN
SCALE 1"=400'

CANAL ℄ STATION 2166+00 TO ℄ STATION 2226+00

CONDITION CLASSIFICATION

CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION

℄ 2166 - ℄ 2172 - TYPE D
℄ 2172 - ℄ 2223 - TYPE A
℄ 2223 - ℄ 2226 - TYPE E

SOUTH OUTBOARD SECTION - ENTIRELY IN CUT
NORTH OUTBOARD SECTION - LOW FILLS WITH MODERATE TO LARGE TOP WIDTHS AND GENTLE SLOPES
- MODERATE TO HIGH HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

NONE

EMBANKMENT SEEPAGE PROBLEMS

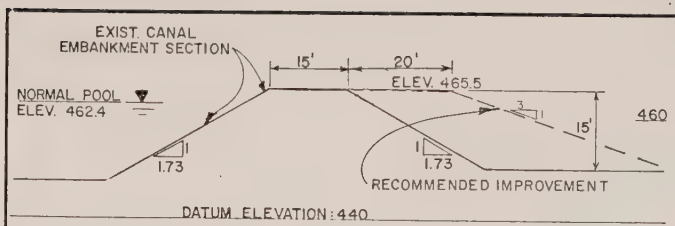
NONE

STRUCTURE FOUNDATION PROBLEMS

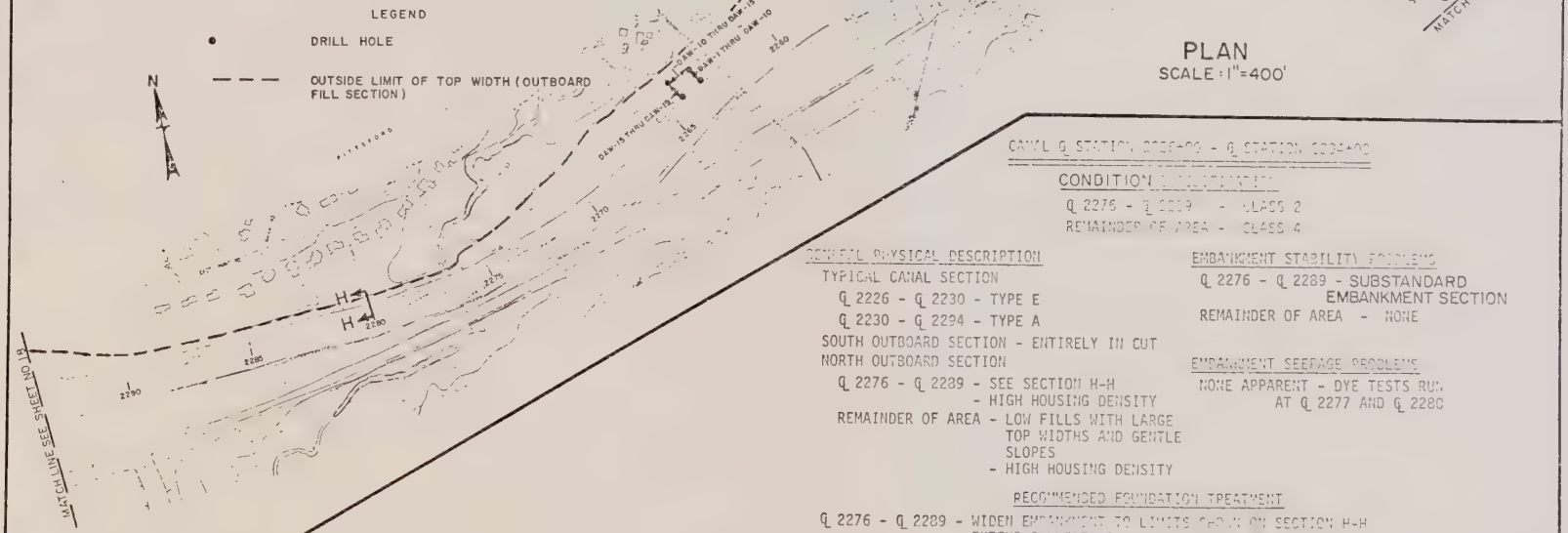
CULVERT NO. 31 SILTED IN
REMAINDER OF AREA - NONE

RECOMMENDED FOUNDATION TREATMENT

CLEAN OUT CULVERT NO. 31



SECTION H-H
SCALE: 1"=20'



PLAN
SCALE: 1"=400'

CANAL ℄ STATION 2226+00 - ℄ STATION 2294+00

CONDITION ASSESSMENT

℄ 2276 - ℄ 2289 - CLASS 2
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION
℄ 2226 - ℄ 2230 - TYPE E
℄ 2230 - ℄ 2294 - TYPE A
SOUTH OUTBOARD SECTION - ENTIRELY IN CUT
NORTH OUTBOARD SECTION
℄ 2276 - ℄ 2289 - SEE SECTION H-H
- HIGH HOUSING DENSITY
REMAINDER OF AREA - LOW FILLS WITH LARGE TOP WIDTHS AND GENTLE SLOPES
- HIGH HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

℄ 2276 - ℄ 2289 - SUBSTANDARD EMBANKMENT SECTION
REMAINDER OF AREA - NONE

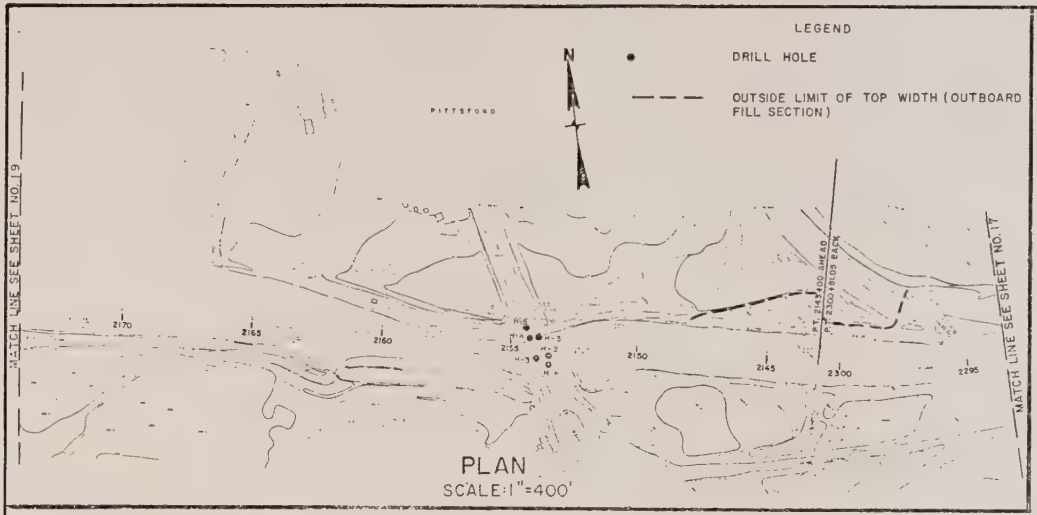
EMBANKMENT SEEPAGE PROBLEMS

NONE APPARENT - DYE TESTS RUN AT ℄ 2277 AND ℄ 2280

RECOMMENDED FOUNDATION TREATMENT

℄ 2276 - ℄ 2289 - WIDEN EMBANKMENT TO LIMITS SHOWN ON SECTION H-H
- EXTEND CULVERT NO. 33 TO TOE OF NEW SLOPE
- BORING AND PERIODIC FIELD MONITORING FOR SEEPAGE.

REMAINDER OF AREA - NONE



CANAL ℄ STATION 2124+00 - ℄ STATION 2175+00 (INCLUDES STATION EQUALITY)

CONDITION CLASSIFICATION

CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION

℄ 2294 - ℄ 2175* - TYPE A

* EQUALITY

SOUTH AND NORTH OUTBOARD SECTIONS - SMALL EARTH CUTS OR LOW FILLS WITH LARGE TOP WIDTHS AND GENTLE SLOPE

- LOW HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

NONE

EMBANKMENT SEEPAGE PROBLEMS

NONE

STRUCTURE FOUNDATION PROBLEMS

NONE

RECOMMENDED FOUNDATION TREATMENT

NONE

CANAL ℄ STATION 2175+00 TO LOCK 33

CONDITION CLASSIFICATION

LOCK 33 BYPASS DAM STRUCTURE - CLASS 2
REMAINDER OF AREA - CLASS 4

GENERAL PHYSICAL DESCRIPTION

TYPICAL CANAL SECTION

℄ 2175 - LOCK 33 - TYPE A

SOUTH AND NORTH OUTBOARD SECTIONS - SMALL EARTH CUTS
- LOW TO MODERATE HOUSING DENSITY

EMBANKMENT STABILITY PROBLEMS

NONE

EMBANKMENT SEEPAGE PROBLEMS

NONE

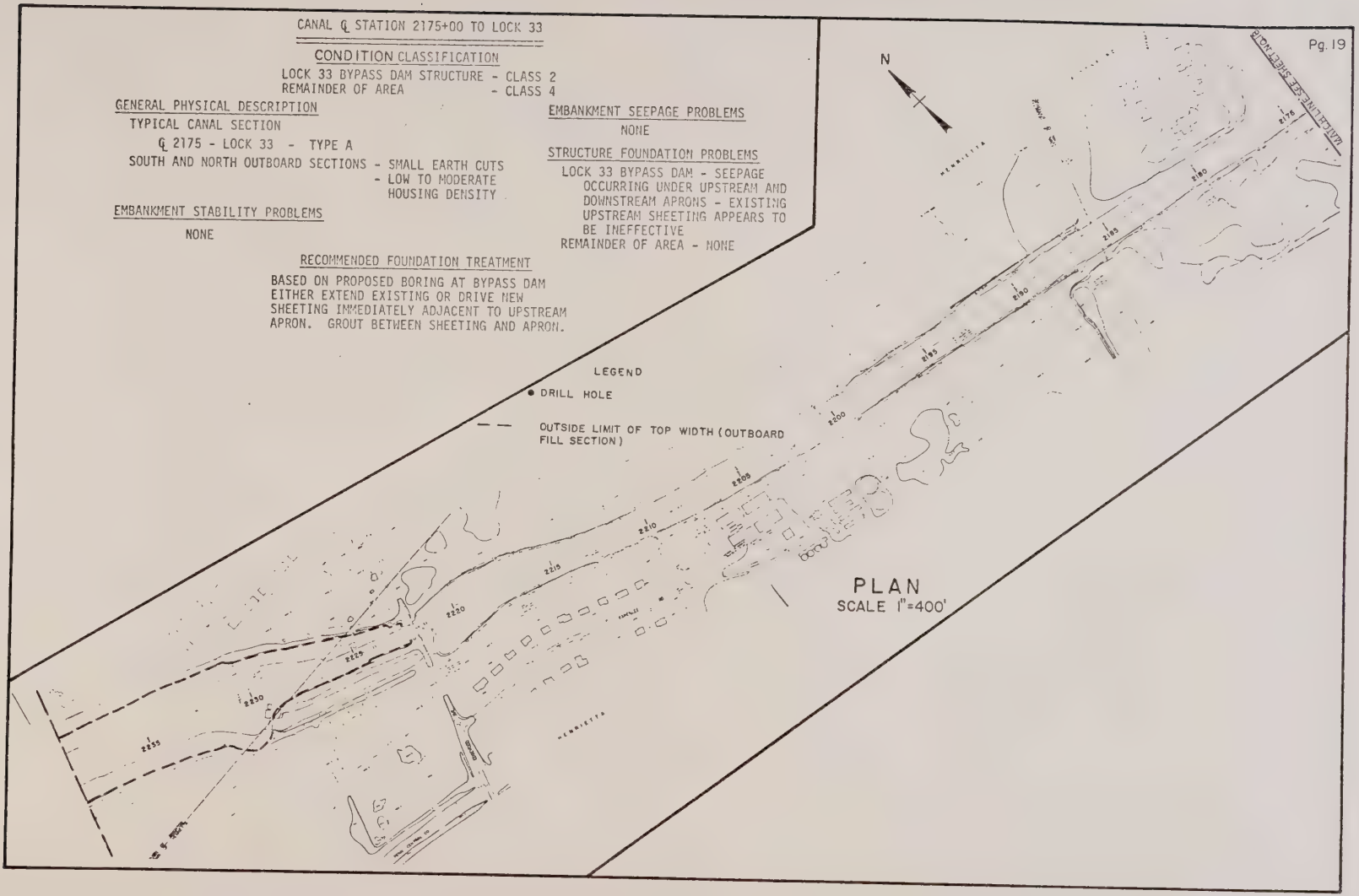
STRUCTURE FOUNDATION PROBLEMS

LOCK 33 BYPASS DAM - SEEPAGE OCCURRING UNDER UPSTREAM AND DOWNSTREAM APRONS - EXISTING UPSTREAM SHEETING APPEARS TO BE INEFFECTIVE

REMAINDER OF AREA - NONE

RECOMMENDED FOUNDATION TREATMENT

BASED ON PROPOSED BORING AT BYPASS DAM EITHER EXTEND EXISTING OR DRIVE NEW SHEETING IMMEDIATELY ADJACENT TO UPSTREAM APRON. GROUT BETWEEN SHEETING AND APRON.



PLAN
SCALE 1"=400'

FOUNDATION TREATMENT CONSIDERATIONS

The recommended foundation treatment shown on the station by station summaries should be accomplished using established procedures.

A. Canal Embankment Widening

The treatment limits shown on the station by station summaries for embankment widening or slope flattening are only approximate. In all areas where these treatments were recommended, survey cross-sections should be obtained. These cross-sections will be used to determine the actual limits of treatment. Widening or flattening operations should be progressed as follows in areas where sufficient right of way exists.

1. Strip all topsoil, sod, and vegetation from area to be improved.
2. Extend any existing drainage structures beyond toe of improved slope.
3. Bench existing embankment in accordance with New York State Department of Transportation Standard Sheet 203-2 before placement and compaction of additional embankment.
4. Embankment material and placement procedures should be in accord with Section 203 of the New York State Department of Transportation Standard Specifications of January 1, 1973.

In areas of limited right of way, embankment widening or slope flattening may be accomplished by constructing a concrete retaining wall near the right of way limit.

1. These walls should be designed in accordance with Figures 20A or 20B, Section 20 of the New York State Highway Design Manual.
2. Any utilities which must be extended through the wall should be independent of the wall and surrounded with filter material.

B. Seepage Control

Positive, permanent elimination of seepage is difficult and expensive to achieve. The primary purpose of the seepage treatments recommended in this report is to prevent embankment instability due to seepage forces or piping and to substantially reduce large losses of canal water.

1. Any drainage structures which are now defunct or will be abandoned in the future should be positively blocked.
2. All existing drainage pipes which are to be extended in connection with remedial embankment treatment should be fitted with anti-seep collars to increase flow path by 15 percent.
3. Sheet pile walls which are recommended for seepage cutoff should be installed at the centerline of the top of embankment. As noted in the summaries, borings will be

required in some locations to determine sheeting depth. In areas where sheeting cannot penetrate to the desired depth, pressure grouting may be required to seal the zone below the sheeting toe.

C. Drainage Structures

The inspection disclosed that all of the drainage structures in this section were stable. However, all existing functional drainage structures and outlet channels must be periodically cleaned of silt and debris to prevent clogging and the resulting build-up of seepage forces.

1. Borings are being progressed through the concrete floor of the canal in the vicinity of Irondequoit Creek to determine if any voids exist beneath the slab. Any remedial treatment required for this area will be transmitted after the analysis of these borings is completed.

D. Slope Vegetation

Vegetation is planted on embankment slopes to minimize surface infiltration, prevent surface sloughing and to beautify the area. Certain types of vegetation such as grass, shallow rooted plants or creeping vines are well suited to this task. However, natural indiscriminate regeneration such as large bushes, trees and other dense, high vegetation tend to mask or create slope problems.

At the present time such dense vegetation exists on the canal slopes as to make inspection an extremely difficult job at best. In addition a large number of trees which vary in diameter from a few inches to several feet, grow on the slopes.

These trees present a multi-faceted problem. If the trees continue to grow, the root growth will continue to damage culverts and the interior concrete lining of the canal. Large trees present the greatest problem. This problem is most severe in areas where narrow substandard embankments exist. The roots also provide a natural seepage path for water from the canal. Selective thinning of smaller trees may increase the chance of toppling large trees due to the destruction of the "canopy effect."

If the trees are cut and not poisoned, root growth may continue indefinitely and only the problem of sudden failure has been alleviated. If the stumps are poisoned and die, decay will occur over a period of years and may create seepage problems.

After careful consideration of this problem we recommend the following treatment.

1. Remove and control all undesirable vegetation except grass and shallow creepers on slope areas with Class 1 or 2 condition classification. Remove all trees and poison the remaining stumps.

2. For all other slope areas i.e., condition classification 3 or 4, remove and control regrowth of dense high vegetation. Remove all trees with diameters 6" or less and poison the stumps. Removal of larger trees is not required as the stability of embankments under classes 3 and 4 would not be endangered if these large trees were suddently toppled or uprooted.

3. All stump poisoning and vegetation control should be done in accordance with the New York State Department of Transportation Herbicide Manual prepared by the Landscaping Bureau in March, 1975.

4. Any areas which undergo complete removal of vegetation should be mulched and seeded immediately in order to prevent erosion by surface runoff.

APPENDIX

ROCHESTER
ROCHESTER
Rochester
Pittsford
LIMITS OF MAPPING
P I T T S F
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TERRAIN UNITS

1	THICK TILL
2	THIN TILL
3	MORAINIC TILL
4	ICE-CONTACT DEPOSITS
5	OUTWASH DEPOSITS
6	LACUSTRINE SHORE DEPOSITS
6/7	LACUSTRINE SHORE DEPOSITS OVER LACUSTRINE BOTTOM SEDIMENTS
7	LACUSTRINE BOTTOM SEDIMENTS
7/1	LACUSTRINE BOTTOM SEDIMENTS OVER THICK TILL
10	RECENT ALLUVIAL DEPOSITS
13	ORGANIC DEPOSITS
17	MAN-MADE FEATURES
18	URBAN LAND
PD	POORLY DRAINED VARIANT

SCALE 1: 24000

1 1/2 0 1 MILE

N

GENERALIZED TERRAIN MAP

PREPARED BY
SOIL SURVEY AND MAPPING UNIT
SOIL MECHANICS BUREAU
N.Y.S. DEPARTMENT OF TRANSPORTATION

JUNE 1975

GENERAL TERRAIN UNIT CHARACTERISTICS

MAP SYMBOL	TERRAIN UNIT	MODE OF ORIGIN	LANDFORMS	COMMON TOPOGRAPHIC POSITION	PARTICLE SIZE AND DISTRIBUTION	RELATIVE PERMEABILITY	REMARKS
1	THICK TILL	SEDIMENTS PICKED UP, TRANSPORTED, MIXED, AND DEPOSITED BY GLACIAL ICE; MINIMAL WATER TRANSPORT; COMPACTION BY OVERRIDING ICE OR SETTLING DURING DEWATERING.	LONG, SIMPLE SLOPES; STEEP TO LEVEL SURFACES; DRUMLINS.	UPLANDS; FLANKS AND TOPS OF HILLS.	CLAY TO BOULDERS; -3" FRACTION MOSTLY SAND AND SILT. GENERALLY UNSORTED AND UNSTRATIFIED; MINOR WATER-SORTED POCKETS.	SLOW	HARD LAYER [illegible] MAY PREVENT DOWNWARD MOVEMENT OF WATER.
2	THIN TILL	SEDIMENTS PICKED UP, TRANSPORTED, MIXED, AND DEPOSITED BY GLACIAL ICE; MINIMAL WATER TRANSPORT; COMPACTION BY OVERRIDING ICE OR SETTLING DURING DEWATERING.	MODERATELY STEEP TO STEEP VALLEY SIDES; HILLTOPS	STEEPER UPLAND SLOPES; INCISED DRAINAGEWAYS.	CLAY TO BOULDERS; -3" FRACTION MOSTLY SAND AND SILT. GENERALLY UNSORTED AND UNSTRATIFIED; MINOR WATER-SORTED POCKETS.	SLOW	DEPTH TO BEDROCK LESS THAN [illegible] FEET. [illegible] NEAR BEDROCK SURFACE.
3	MORAINIC TILL	SEDIMENTS DUMPED FROM MARGIN OF MELTING ICE; PARTIALLY WATER-WORKED	LONG COMPLEX SLOPES; IRREGULAR HILLY SURFACES.	UPLANDS; LOWER VALLEY WALLS.	CLAY TO BOULDERS; -3" FRACTION MOSTLY SAND AND SILT. UNSORTED OR VERY POOR SORTING; LITTLE OR NO STRATIFICATION.	MODERATE TO RAPID	USUALLY OCCURS WITH OR CLOSELY ASSOCIATED WITH [illegible] ICE-CONTACT DEPOSITS.
4	ICE-CONTACT DEPOSITS	WATERBORNE SEDIMENTS DEPOSITED AGAINST ONE OR MORE WALLS OF ICE.	KAMES, ESKERS, ETC.; SINUOUS RIDGES OR RANDOM CONICAL HILLS AND DEPRESSIONS OF MODERATE RELIEF.	VALLEY WALLS AND FLOORS SUPERIMPOSED ON LANDSCAPE.	SILT, SAND, GRAVEL; OCCASIONAL COBBLES. WELL-SORTED BEDS. IRREGULAR, FAULTED AND SLUMPED STRATIFICATION.	MODERATE TO RAPID	ASSOCIATED WITH [illegible] TILL OR SILT.
5	OUTWASH DEPOSITS	SEDIMENTS TRANSPORTED BY MELTWATERS AWAY FROM ICE MASS.	FLAT TO GENTLY UNDULATING TERRACES.	LOWER VALLEY WALLS AND FLOORS.	SILT TO COBBLES, MOSTLY SAND AND GRAVEL. WELL-SORTED, MASSIVE, HORIZONTAL STRATIFICATION WITH SOME BEDDING.	MODERATE TO RAPID	MAY HAVE HIGH WATER TABLE.
6	LACUSTRINE SHORE DEPOSITS	SEDIMENTS TRANSPORTED BY WATERCOURSES FLOWING INTO GLACIAL LAKES AND SETTLING; WAVE ACTION ALONG SHORES.	DELTAS, BEACHES, BARS; LOW RIDGES; BERMS; FLAT TO GENTLY UNDULATING PLAINS.	HIGH ON VALLEY WALL; EDGES OF VALLEY FLOOR. EDGES OF LOWLANDS.	SILT TO COBBLE; MOSTLY FINE SANDS AND SILT, LITTLE CLAY. WELL-SORTED BEDS; DISTINCT LEVEL OR SLOPING STRATIFICATION.	MODERATE TO RAPID	MAY BE UNDERLAIN BY LACUSTRINE CLAYS.
6/7	LACUSTRINE SHORE DEPOSITS OVER LACUSTRINE BOTTOM SEDIMENTS	SEE CHARACTERISTICS FOR EACH TERRAIN UNIT					SAND AND SILT COVER LESS THAN 5 FEET THICK OVER SILT AND CLAY
7	LACUSTRINE BOTTOM SEDIMENTS	SEDIMENTS DEPOSITED IN DEEP, QUIET WATER OF GLACIAL LAKES.	FLAT TO GENTLY UNDULATING PLAINS.	VALLEY WALLS; VALLEY FLOORS; LOWLANDS.	CLAY TO FINE SAND; MOSTLY SILT. WELL-SORTED BEDS; NEARLY HORIZONTAL, DISTINCT STRATIFICATION.	SLOW	SEDIMENTS MAY CONTAIN COBBLES AND BOULDERS.

GENERAL TERRAIN UNIT CHARACTERISTICS

MAP SYMBOL	TERRAIN UNIT	MODE OF ORIGIN	LANDFORMS	COMMON TOPOGRAPHIC POSITION	PARTICLE SIZE AND DISTRIBUTION	RELATIVE PERMEABILITY	REMARKS
7/1	LACUSTRINE BOTTOM - SEDIMENTS OVER THICK TILL	SEE CHARACTERISTICS FOR EACH TERRAIN UNIT					SILT AND CLAY COVER LESS THAN 3 FEET THICK OVER GLACIAL TILL
10	RECENT ALLUVIAL DEPOSITS	SEDIMENTS DEPOSITED BY FLOODWATERS.	FLOODPLAINS SUBJECT TO OVERFLOW.	ALONG WATERCOURSES.	CLAY TO COBBLES; MOSTLY SAND AND SILT; ORGANIC SURFACE. WELL-SORTED BEDS; WEAK STRATIFICATION. FINER TEXTURES FARTHER FROM WATERCOURSE.	VARIABLE; HIGH WATER TABLE.	USUALLY UNDERLAIN BY ADJACENT DEPOSITS.
13	ORGANIC DEPOSITS	ACCUMULATION OF ORGANIC AND INORGANIC MATERIAL IN BODY OF WATER	DEPRESSIONS	ALONG WATERCOURSES HEADWATERS OF UPLAND STREAMS; VALLEY FLOOR DEPRESSIONS.	CLAY TO FINE SAND; ORGANIC MATTER; POSSIBLY MARL. UNSORTED; IRREGULAR STRATIFICATION.	VARIABLE; HIGH WATER TABLE.	
17	MAN MADE FEATURES	USUALLY OCCURS ADJACENT TO BARGE CANAL AS TOW PATH EMBANKMENTS, SPOIL BANKS, CUT SLOPES OR BORROW PITS.					ASSOCIATED WITH ALLUVIAL LANDS
18	URBAN LAND	THE HIGH DEGREE OF URBAN DEVELOPMENT HAS COMPLETELY MASKED THE ORIGINAL TERRAIN UNITS.					
1PD 5PD 6PD 7PD 10PD	POORLY DRAINED VARIANT	THESE ARE THE POORLY DRAINED PHASES OF THE ABOVE TERRAIN UNITS. THEY ARE SIMILAR IN CHARACTER TO THE DESCRIBED UNIT EXCEPT THAT THE SOIL REMAINS WET FOR A LARGE PART OF THE TIME. THESE SOILS ARE USUALLY WATER LOGGED DURING LATE FALL, WINTER AND EARLY SPRING. THE WATER TABLE REMAINS NEAR THE SURFACE EXCEPT DURING THE USUALLY WARM DRY MONTHS.					

HISTORY OF CANAL STUDY AREA

The New York State Barge Canal system was the outgrowth of the many canals constructed in the State during the 19th Century. Even with the improvements and enlargements to the Erie Canal over the years, by the advent of the 20th Century it was outmoded and in need of continual maintenance. The Barge Canal was approved by voter referendum and constructed under the appropriate chapters of the laws of 1903, 1909 and 1911.

The Barge Canal Bulletin of the Department of the State Engineer and Surveyor (Series II, No. 6) gives the route of the Barge Canal in the study area as being:

> To the east of the (Genesee) river a hill is encountered, requiring a cut of 63 feet at the greatest depth. Then low ground is traversed, upon which there must be an embankment, a maximum of 42 feet to top of side banks being necessary. About a mile west of Pittsford the line of the present (Erie) canal is regained and followed with short deviations to Palmyra. Two locks occur in the stretch between the Genesee and Pittsford, the lift of each being 25.1 feet.
>
> Across the Irondequoit valley the canal will be carried on high embankment, as at present. To guard against the serious results of a bad break, a guard-gate will be placed at each end of the embankment, with a spillway just west of the westerly gate. Just to the west of the creek culvert the channel will consist of a concrete trough, made with ordinary retaining-wall sides and a reinforced concrete bottom and placed on top of the embankment.

Construction of the Barge Canal in the study area was accomplished by dividing the area into several contracts. Three main contracts were utilized, being Numbers 23, 63 and 41. First of these contracts to be let was Contract 41 for the forming of embankments at Irondequoit Creek crossing, including the construction of culverts and drains, etc. Work began in May 1909, with material from adjacent borrow pits being removed, placed on the embankment and compacted by streams of water constantly playing on the fill. The material was mostly a fine sand, easily handled. Unsuitable material was removed by hydraulic dredge from the fill site and the Irondequoit Creek relocation. By December 1910, the project was completed except for the clay lining which was later deleted from the contract.

Contract 63 called for enlarging the present canal and constructing culverts, sluiceways, waste-weir, guard-gates, dock walls, bridges, highway changes, etc., between Wayne-Monroe County line and King's Bend (the point where the Barge Canal diverges from the old Erie Canal west of Pittsford). Work on this contract began September 1910.

Enlargement of the existing canal was done by steam-shovel, hydraulic dredge and various other excavators. Material was removed from the prism and put on embankment or spoiled. Work commenced on the concrete trough over the previously built embankment at Irondequoit valley in June 1911, and was practically completed by mid-October 1911.

Starting in May 1913, steel sheeting was driven in the north side of the tow path between Bushnell's Basin guard-gate and the widewaters near Fairport. Also the embankments behind the trough were completed and trimmed. Filling of the Cartersville widewaters began with material from a borrow pit north of the canal. At the beginning of 1914, the old and new canals were joined at the west end of the trough with material being spoiled into the old canal. The contract was terminated, uncompleted, in December 1914.

Contract 63-A was let for completing the unfinished work on Contract 63 and ran from February 1916, to December 1918, when it too, was terminated. A major portion of the work was to repair damage to the trough and embankment which occurred in September 1912. According to Noble E. Whitford's History of the Barge Canal (1921): "The break was occasioned apparently by the giving away of the culvert which carried Irondequoit Creek under the embankment. This caused the trough to break and the escaping canal waters washed out about 500 feet of embankment." A wooden trough 887 feet long, 22 feet wide inside and with a water depth of 7 feet was built to keep navigation open. New embankment was started in July 1916, as was concrete for trough. Work was completed by May 1918, and the contract terminated in December. Contract 201 was let to complete the miscellaneous work remaining at Cartersville.

Whitford in his History of the Barge Canal (1921) comments: "The reconstructed trough was not designed to carry the whole weight of the water as an aqueduct would. Rather the underlying thought was to prevent serious breaks by not allowing leakage to get a start. The plan was very simple - just two courses of concrete in the bottom of the prism with a layer of screened gravel between. In the gravel were laid lines of drain tile every twenty feet and on top of the upper course of concrete tar felt waterproofing was placed. The side walls, well joined to the bottom courses, were about standard design except that inspection chambers six and a half feet high ran through them lengthwise and at the side of these chambers was a channel into which emptied the lines of drain tile. The side walls were well backed by embankments at least 22 feet wide at the top and sloping down on a one on three slope."

Contract 23 called for prism excavation, constructing Lock Nos. 32 and 33, etc., between King's Bend and the east bank of the Genesee River. Work started in July 1909, and the contract terminated in March 1915. Excavation east of Lock No. 33 and for Lock Nos. 32 and 33 was mostly by steam-shovel. Material was mostly spoiled but

material excavated from the hill west of Lock No. 33 was utilized for embankment. Compaction of this material was by roller, either a 3400-pound horse-roller or a 13-ton steam roller with grooved wheels.

Concreting began on Lock No. 32 in November 1910, and on Lock No. 33 in July 1911, and was completed by October 1912. The prism east of Lock No. 33 to King's Bend was completed by October 1912.

Contract 23-A was let in May 1916, for the completion of Contract 23, most work being west of Lock No. 33. Miscellaneous work on Lock Nos. 32 and 33 was completed. Contract 23-A was terminated in December 1918. Another contract, No. 190, was let to complete the project.

Appendix C

STABILITY OF CANAL EMBANKMENTS DURING EARTHQUAKE CONDITIONS

The section of the canal covered in this report is situated in an essentially stable zone with respect to earthquake activity (Ref. 1). The stability of the canal embankments in the study area during an earthquake has been analyzed using two distinct methods; liquefaction potential and lateral acceleration.

Most of the failures of and displacements in earth dams caused by earthquakes have been ascribed to liquefaction. The potential for liquefaction of the Barge Canal embankments has been analyzed in accordance with the methods presented in Ref. 2. It has been found that, in order not to liquefy during the design earthquake, the foundation and embankment soils have to exhibit a minimum penetration resistance of 2 blows per foot by the Standard Penetration Test used in subsurface soil explorations. The soils encountered in the borings progressed along this section of the canal meet this requirement.

The analysis when lateral earthquake acceleration is applied to a potential sliding mass results in the following criteria for stable outboard slopes:

A. For embankment slopes with low groundwater levels. This criterion applies to areas where the canal section contains a relatively impervious lining, or a sheetpile wall, or where a low groundwater level is confirmed by observation wells installed in the embankment. For safety against breaching of the canal during the design earthquake, the slope of a straight line connecting the top of the lining with the outboard toe of slope should not be steeper than 1 vertical on 2-1/2 horizontal.

B. For embankment slopes with a presumed high groundwater level. These criteria apply to areas where the canal section does not contain a relatively impervious (such as Portland cement concrete) lining and where a low groundwater level is not disclosed by observation wells:

Steepest permissible outboard slope for earthquake stability

Embankment Height	Embankment top width: W* = 14' to 17.5'	Embankment top width: W* = 10' + 1/2 H**	Embankment top width: W* = 10' + H**
less than or equal to 15'	1 on 3	1 on 3	1 on 2***
more than 15'	1 on 3-1/2	1 on 3	1 on 2***

*W = top width of embankment
**H = height of embankment
*** = if evidence of seepage is not noticeable on surface of slope

For the purpose of this earthquake stability analysis we assumed that inboard slopes would have an inclination of 1 vertical on 3 horizontal where the canal section is not lined with concrete or does not contain sheet piling.

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3. Seed, H. B. & I. M. Idriss, "A Simplified Procedure for Evaluating Soil Liquefaction Potential," Earthquake Engineering Research Center, University of California, Berkeley, November 1970.

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